# NOAA Interests in Hyperspectral Sounders

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and

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# Interests

- Improvements in hyperspectral IR soundings to address current limitations with respect to user needs (spatial, temporal, spectral)

- Future operational instruments for monitoring GHGs - sources and sinks, transport, etc.

# NOAA User Requirements

- Weather forecasting
  - Improvements in nowcasting, short to medium range forecasting
- Climate monitoring
  - Ozone
  - Greenhouse Gases (CO2, CH4, CO)
  - Temperature/Water Vapor

# NOAA OAR AOML assessment and future needs (Bob Atlas)

- Polar orbiting IR and MW sounders play a vital role in much of the research that we perform to contribute to improved understanding and prediction of weather and climate.

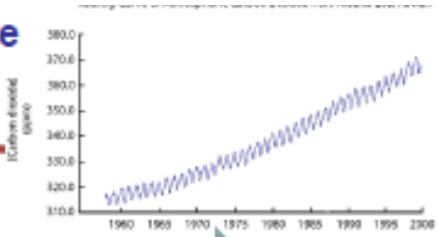
- With regard to tropical cyclones, AIRS has provided extremely valuable data for studying the role of the Saharan Air Layer, and for some cases, for the prediction of tropical cyclone track and intensity.

- For the development of advanced cloud resolving models, we will need observations at nearly comparable resolution for validation and initialization. An AIRS type sounder at 1 km resolution would be extremely valuable in this regard.

# An emerging challenge for US and world (OAR – Jim Butler)

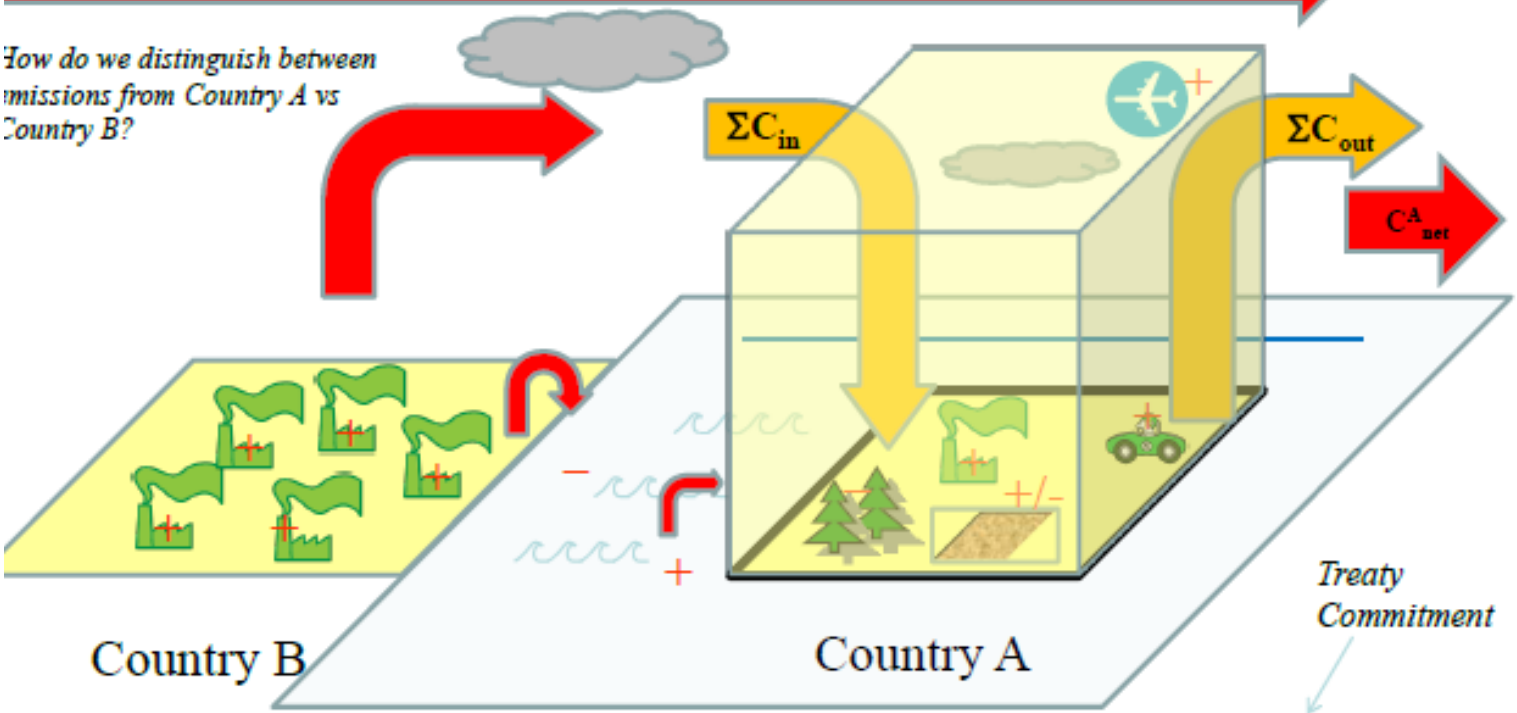
- Society is going to be making efforts to reduce $CO_2$ emissions – probably sooner than later
- These efforts will be regional & sectoral in nature, and diverse in their approach
- No large-scale emission reduction effort has succeeded without verification
  - Stratospheric Ozone
  - Acid Rain
  - Regional Air Quality
- The complexity & variability of the carbon cycle make this a challenging issue

# Challenge: quantifying Country A's treaty compliance in the presence of confounding sources



*How do we distinguish between Country A's total carbon emissions and the global time-varying background?*

*How do we distinguish between emissions from Country A vs Country B?*



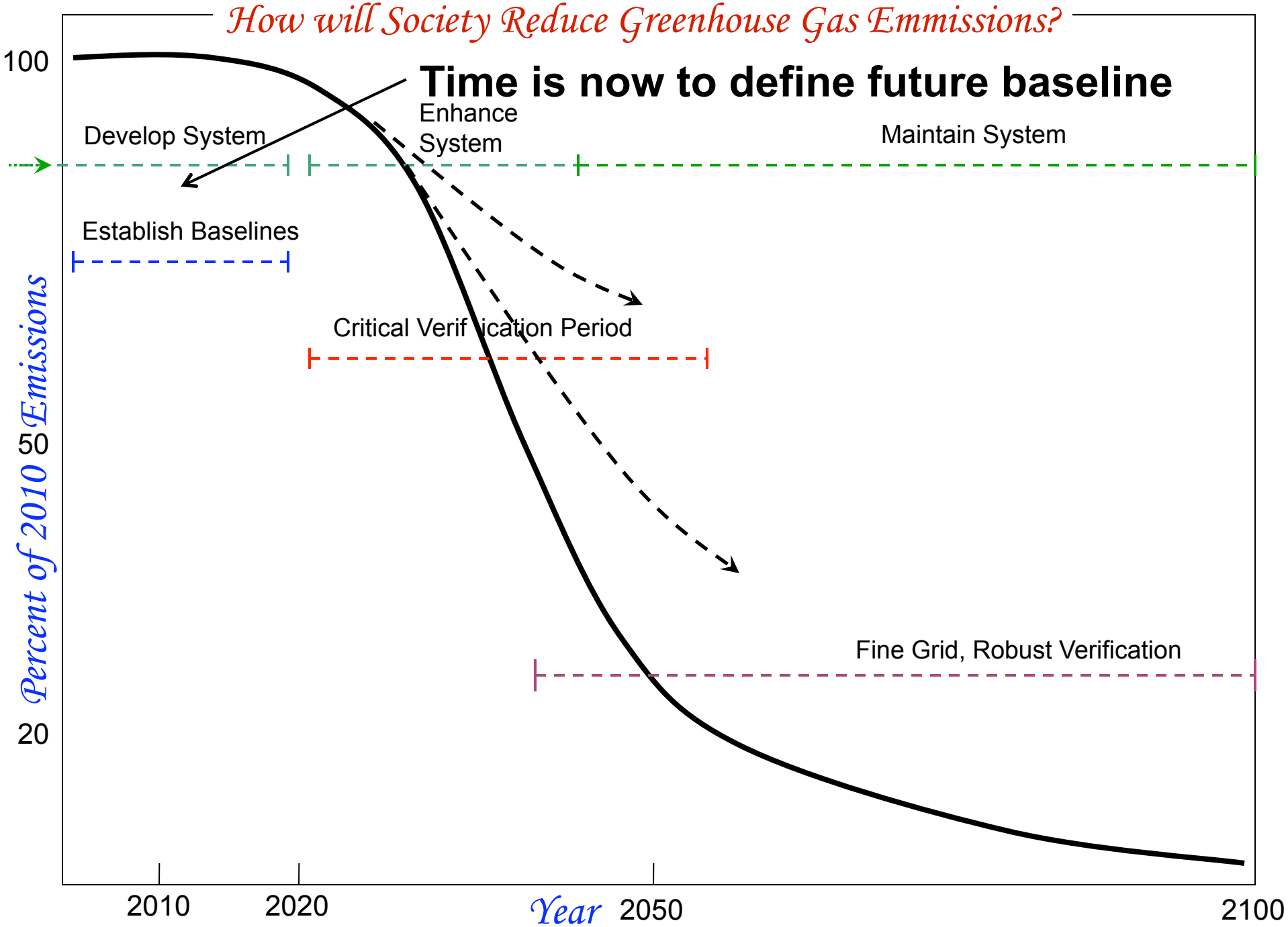

*How do we distinguish between Country A's anthropogenic emissions and the natural, local time-varying background?*

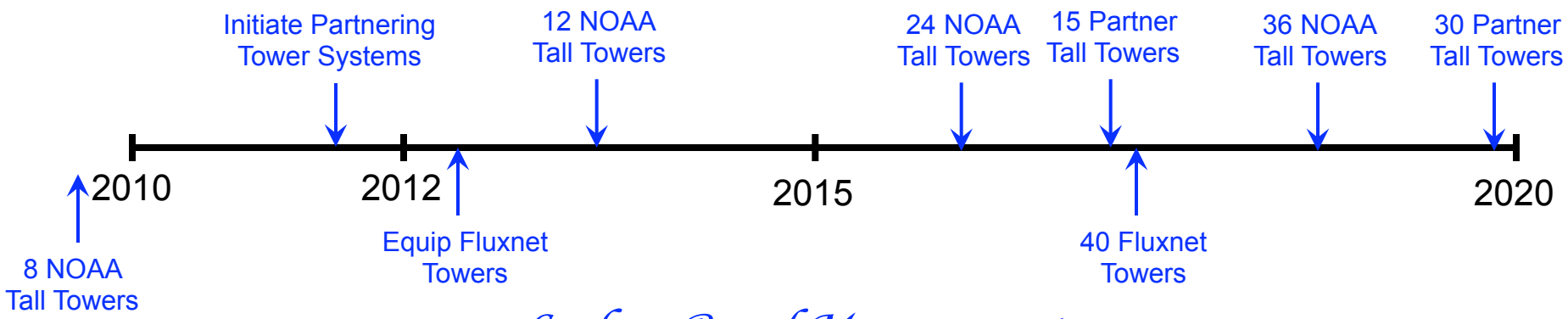
$$C^A_{net} = \Sigma C_{out} - \Sigma C_{in} = C^A_{anth}(t) + C^A_{nat}(t)$$

pre-decisional discussion material

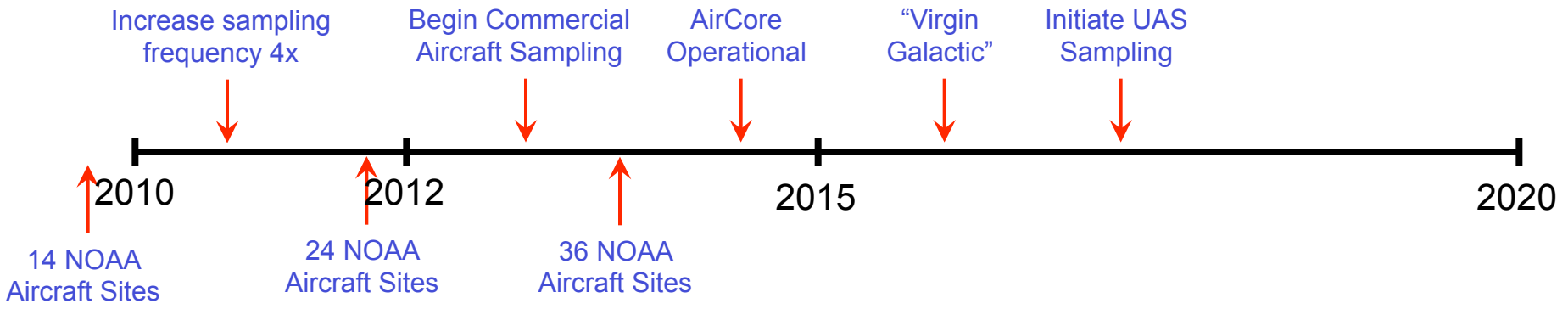


*From Riley Duren, NASA/JPL - NOAA/NASA-GHGIS meeting Feb 09*


How will Society Reduce Greenhouse Gas Emmissions?
Time is now to define future baseline
Develop System
Enhance System
Maintain System
Establish Baselines
Critical Verif ication Period
Fine Grid, Robust Verification
100
50
20
Percent of 2010 Emissions
2010
2020
Year
2050
2100



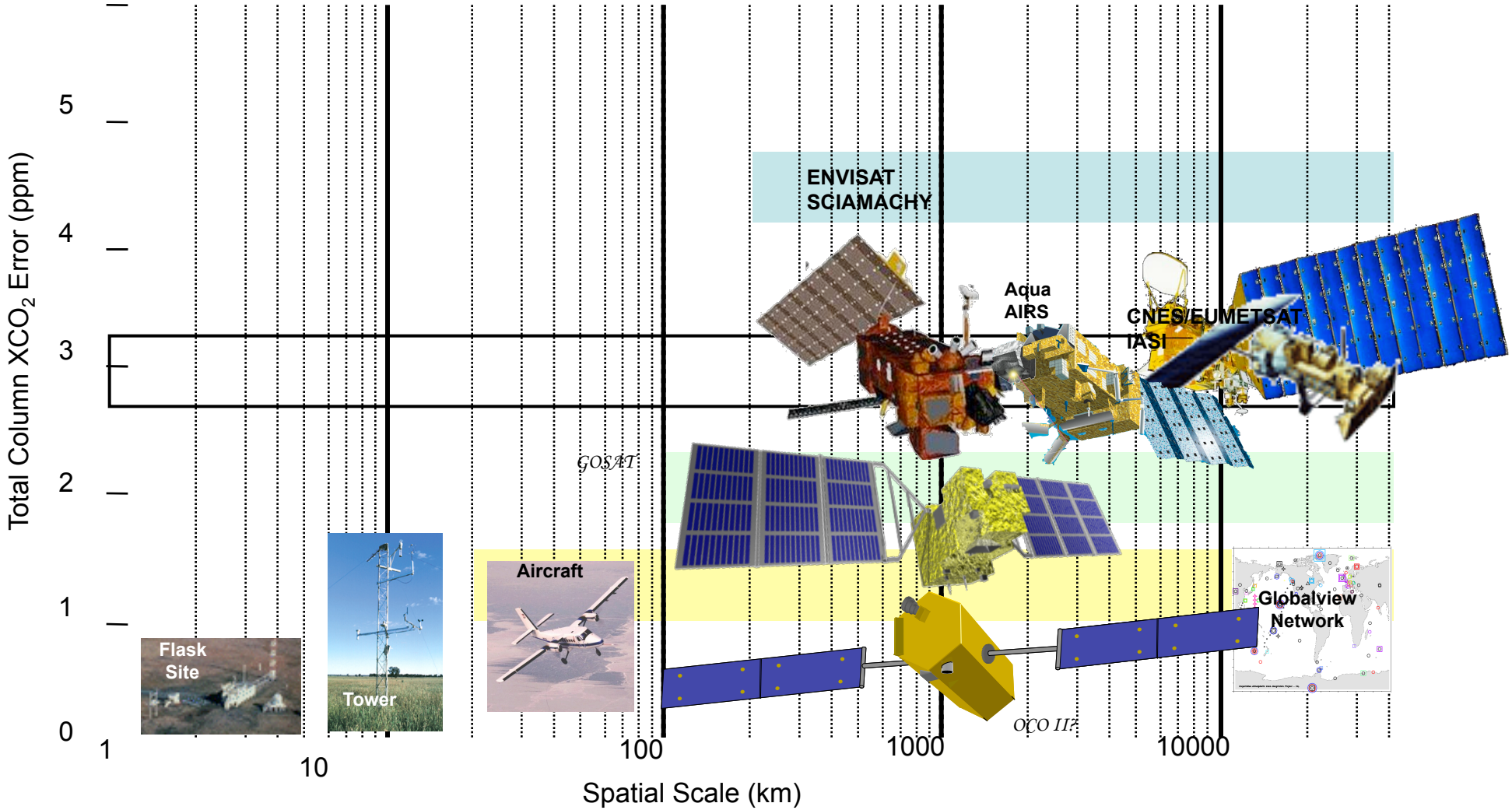

*Surface Based Measurements*




*Aircraft Measurements*

# *Satellite retrievals of carbon fill gaps in scale left by the current surface/tower/aircraft in situ and flask sampling network.*

## *The operational satellite community also needs a plan!!*






*Adapted from D. Crisp*

# Workshop on Hyperspectral Sensor Greenhouse Gas (GHG) and Atmospheric Soundings from Environmental Satellites

- Miami, Florida, U.S., March 29 -31, 2011.
- NOAA-led, co-organizers from NASA, EUMETSAT
- This will be a 3 day workshop focusing on:
  - The current status and the future technologies needed to support sustained global and regional greenhouse gas (GHG) measurements from space for operational satellite programs.
  - The current status and the future technologies needed to support improved weather forecasting at all temporal scales (nowcasting – medium range forecasting

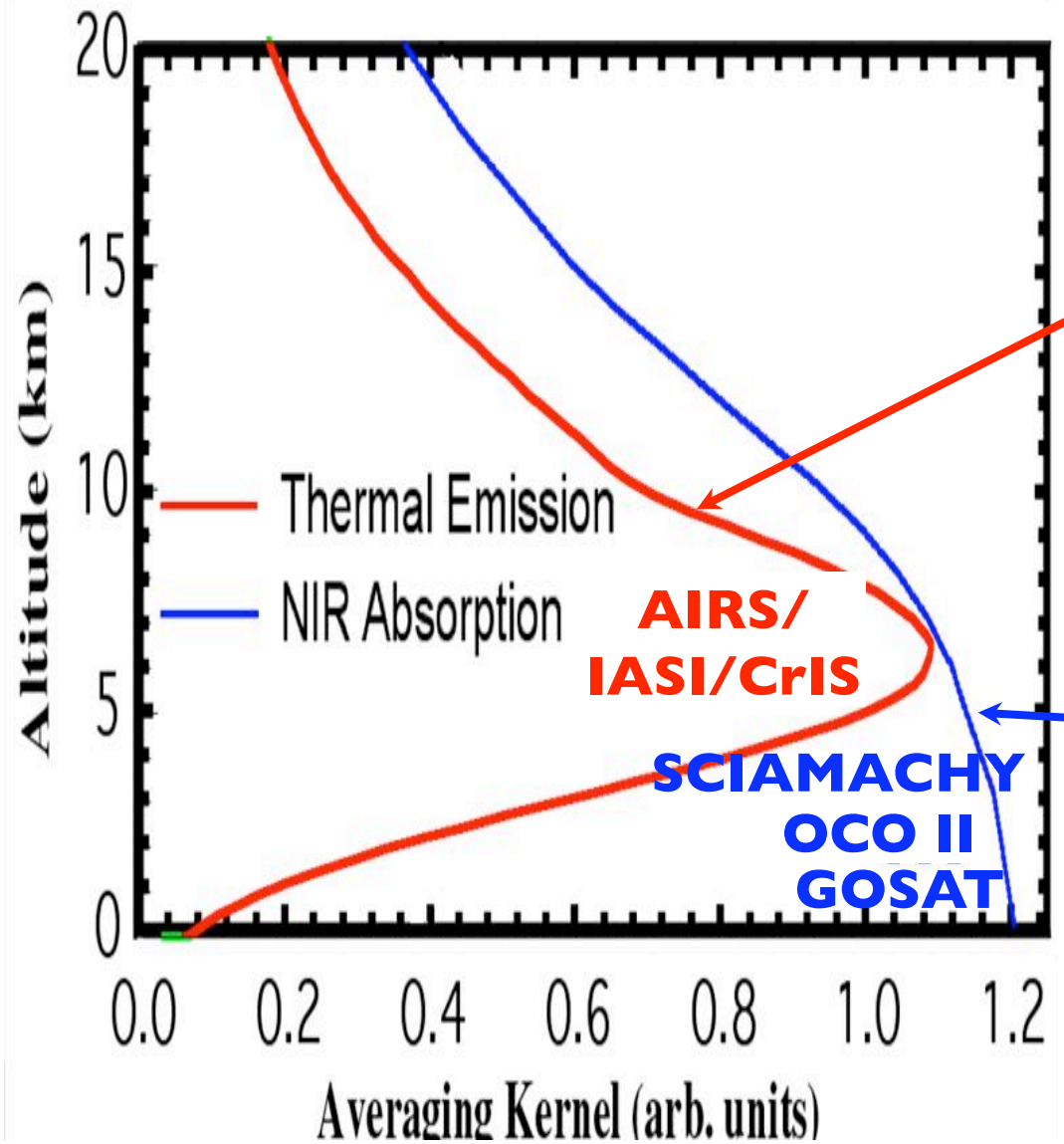
# Workshop will answer a number of questions

- **How are current hyperspectral IR sounders such as the NASA AIRS and CNES & EUMETSAT IASI used by the user community? What are the deficiencies? What improved information is needed by the user?**

- **With respect to the NASA JPL OCO ($CO_2$) GHG directed satellite mission:**
  - **What does NASA see as its capabilities? operational uses?**
  - **What does NASA see as an appropriate NOAA operational follow-on mission?**

- **Can one hyperspectral instrument (FTS or dispersive) satisfy both sounding and GHG requirements?**

# AIRS/IASI/CrIS thermal IR measurements complement the solar/passive measurements by providing an independent upper boundary condition




- Thermal instruments (e.g., AIRS, IASI, CrIS) measure mid-tropospheric column
  - Peak of vertical weighting is a function of T profile and water profile and ozone profile.
  - Age of air is on the order of weeks or months.
  - Significant horizontal and vertical displacements of the trace gases from the sources and sinks.
- Solar/Passive instruments (e.g., SCIAMACHY, OCO II, GOSAT) & laser approaches measure a lower troposphere weighted total column average.
  - Mixture of surface and near-surface atmospheric contribution
  - Age of air varies vertically.

# Is one set of $CO_2$ requirements possible ?

*The Carbon community thinks it is possible … but we must link the range of requirements to applications and expected performance.*

**Requirements**

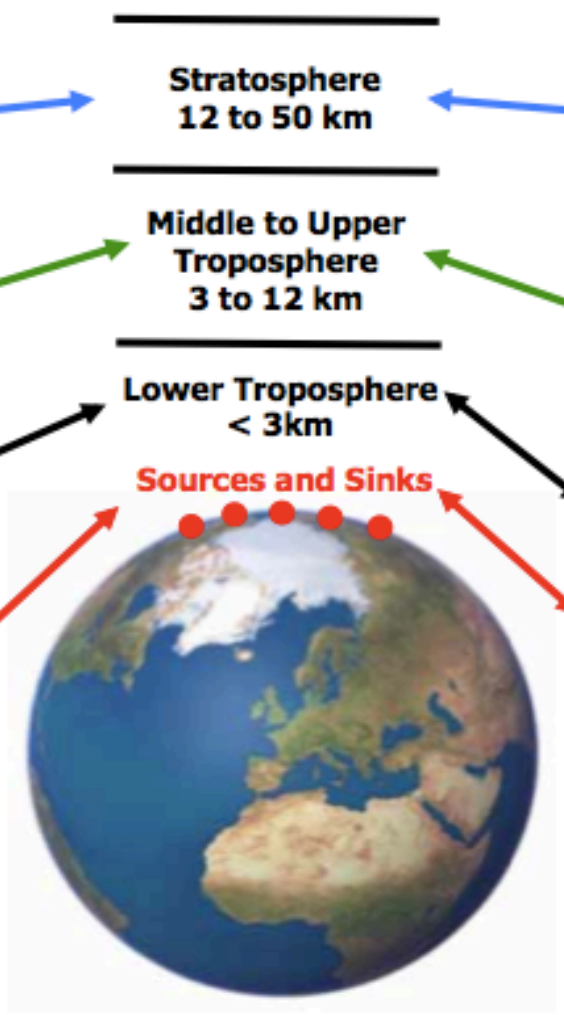
**Stratosphere**
Spatial: 50-500-km
Temporal: 3-hrs to 7-days
Accuracy: 4-8-ppm

**Middle to Upper Troposphere**
Spatial: 10-500-km (transport, climate)
Temporal: 3-24-hrs (multiple daily, diurnal)
Accuracy: <4-ppm (1%)

**Lower Troposphere**
Spatial: 10-500-km (flux studies)
Temporal: 3-24-hrs (multiple daily, diurnal)
Accuracy: <4-ppm (1%)

**Surface**
Spatial: 1-10-km (sources and sinks)
Temporal: 3-24-hrs (intraday variation)
Accuracy: 1-4-ppm (0.25% to 1%)

* *Assume global coverage for all cases.*




**Capabilities**

**Limb Sounders**
ACE, SCIAMACHY, MIPAS

**LW Thermal Emission**
AIRS, IASI, TES, HIRS, CrIS, IRAS

**SW Passive Absorption**
SCIAMACHY, TANSO-FTS, OCO Spec, MiniCarb-FTS, CarbonSat-FTS

**Laser Absorption**
ASCENDS, GOSAT-3, JEM-DIAL, A-SCOPE

# Miami Workshop, March 29-31, 2011

- The current status and the future technologies needed to support sustained global and regional greenhouse gas (GHG) measurements from space for operational satellite programs.

- The current status and the future technologies needed to support improved weather forecasting at all scales (nowcasting – medium range forecasting for operational satellite programs

# Operational Constraints

- Operational missions commit to nearly 20 years flying essentially the same type of instrument.
  - HIRS 35 years
  - IASI 21 years
  - CrIS 21 years
- Mature low risk technology

# This means…….

- Important to assess current capabilities, limitations, and readiness:
  - What technology is ready for the next operational acquisition program?
  - What technology incubator programs should be supported by research agencies so that advanced technology becomes mature for operational missions?
  - What enhancements are needed to improve products and services?